STANDARD FORM NO. 64

CONFIDENTIAL

Office Memorandum • UNITED STATES GOVERNMENT

SPM 9-0606

TO : Chief, Engineering Staff, OC

DATE: 26 January 1959

FROM : Chief, Special Programs Staff, OC

SUBJECT: Quotation, 10 Watt, Fuel Burning Thermoelectric Generator, [redacted] 25X1

1. The attached technical quotation submitted by [redacted] for a 10 watt, fuel burning thermoelectric generator, [redacted] has been thoroughly examined. The technical quotation, plus modifications discussed with the engineering monitor, satisfactorily meets our operational requirements. 25X1 25X1 25X1

2. It is recommended that Allotment Number 9-7900-10-652 be utilized to complete the necessary procurement arrangements.

[redacted] 25X1

Attachment
Technical Quotation

Distribution
Orig. & 1 - Addressee

CONFIDENTIAL

December 12, 1958

The United States Government
Washington 25, D. C.

Subject: Quotation, 10 Watt, Fuel Burning Thermoelectric Generator

STAT

Gentlemen:

We submit the following quotation for a 10 Watt thermoelectric fuel burning generation in response to your recent request.

Outline of Technical Approach:

It appears quite practical to proceed immediately with the design and construction of a fuel burning 10 Watt, 15 volt generator meeting the specifications of your request. Our activities in thermoelectric generator development and construction have established that known thermoelectric materials and design approaches can be utilized in straightforward manner to utility of a delivered unit.

We have conducted successful development activity not only in thermopile construction, but also in liquid fuel burner engineering. Straightforward engineering application of the resultant known principles can produce a generator matching your first step requirements without further invention or original development.

For this reason, we believe it most expeditious and economical to propose design and construction of a generator meeting your initial specifications under a fixed price purchase order.

After delivery of a unit meeting your initial specifications, an accurate conclusion can be reached as to the development required to produce a generator satisfactory in all respects for your intended usage.

In our opinion, the above method of procedure will permit the most rapid and efficient utilization of our development and know-how background.

Our current development activities include wide variation in thermopile assembly and heat source configurations. It would be of mutual advantage during this activity to think in terms of your end goal while producing a first-step model for your test purposes.

The above comments do not preclude our ability to proceed with a tight development program immediately, should your requirements be firm enough to warrant such an approach. Be assured that our interest in satisfying your need in the most satisfactory manner is of sincere concern to us.

The following Enclosures 1, 2 and 3 describe our proposal in detail.

Thank you.

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/rm
Enclosures 1, 2, 3
Sketch

Enclosure 1

STAT

OBJECTIVE SPECIFICATIONS, THERMOELECTRIC GENERATOR

Power Output, Rated	10 Watts
Voltage Output, Rated Load	15 volts D. C. Nominal
Number Semiconductor Couples	125
Overall Efficiency	Approximately 4 %
Heat Source	Ceramic "S" mantle burner operating on leaded gasoline supplied from pressure tank requiring periodic manual pumping, no visible light to show.
Cooling	Case finned for convective air cooling.
Fuel	Leaded or white gasoline.
Fuel Consumption Rate	0.56 pint per 10 hours.
Weight	15 lbs. maximum.
Shock and Vibration	Suitable for normal handling and transport.
Storage	-60°C to +60°C
Operation	100 hours operation without burner maintenance.
Burner Maintenance	Simple cleaning procedure and replacement.
Control	Manual fuel rate adjustment, indicating volt-ammeter.
Accessories	5' output cable with polarity marked battery clips.
Price	$ 46,000 Delivered
Delivery	Four months approximately from date of order.

Enclosure 2

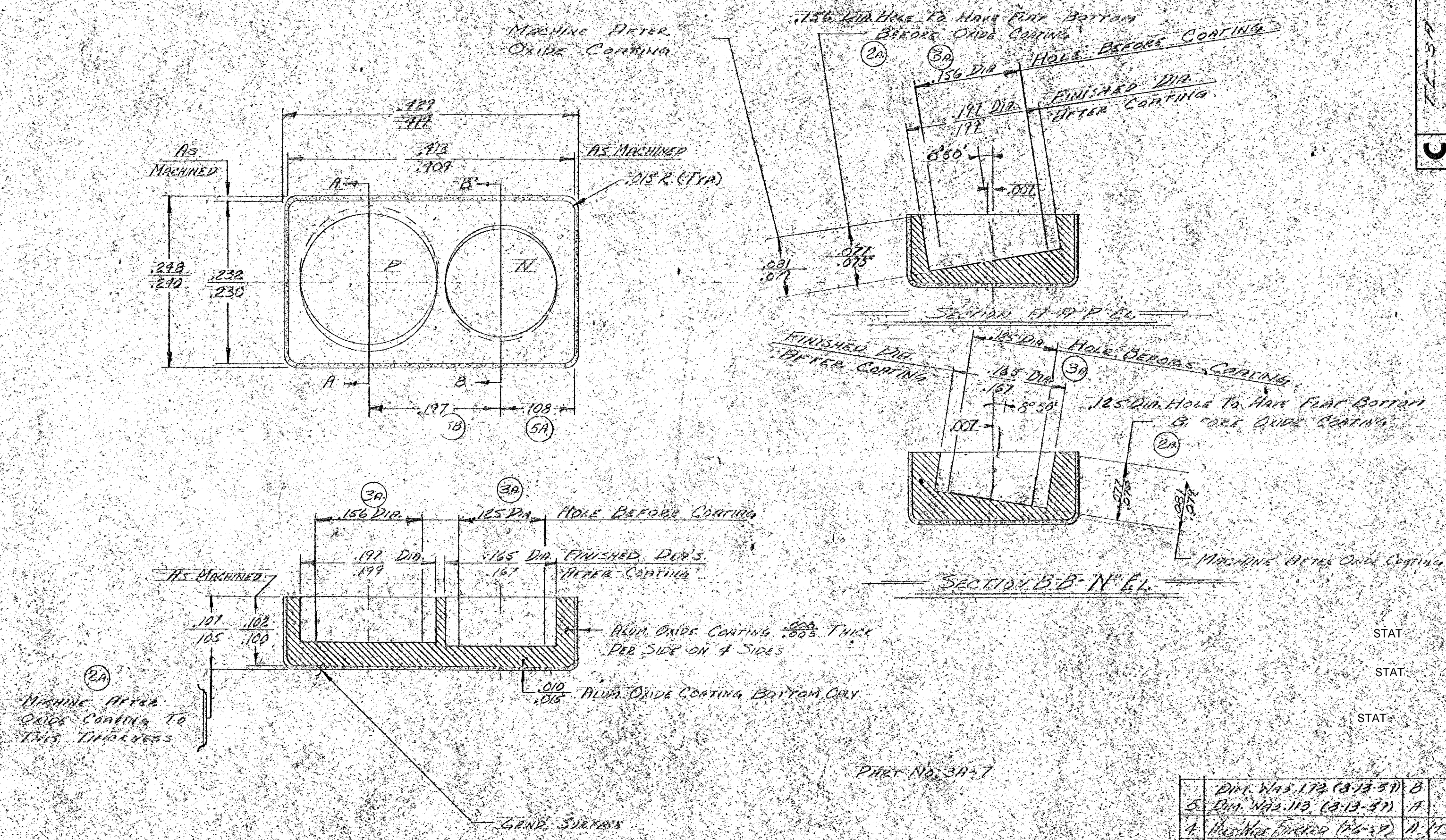
DESCRIPTION OF PROPOSED TEN WATT, GASOLINE BURNING GENERATOR [redacted] STAT

The enclosed sketches C-58-134 and C-58-135 show a thermoelectric generator unit fitted to a proven configuration gasoline burner and also to a dead-end, counterflow burner. This is intended to show two possible arrangements and not necessarily a final design.

Generator output control is achieved by controlling the combustion ratio with a manual fuel adjustment. A small volt-ammeter is to be included to permit proper adjustment.

The burner requires periodic manual pumping to provide pressurized fuel flow to the ceramic burner unit. The fuel is vaporized in the generator tube and there causes air aspiration through the air intake tube. Pre-heating of fuel and air will take place in the tubing within the generator enclosure. It is expected that combustion can be varied from maximum down to approximately 60 per cent of maximum without becoming unstable.

Two design approaches have been considered, primarily from the stand-point of burner configuration. An approach now in development can be described as a "dead-end, counterflow" system. This approach would be incorporated into the generator assembly, provided current proving shows advantage and satisfactory life.



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MAT'L - C.R. STEEL A.I.S.I. 1020
MACHINE - ALL MILL SCALE REMOVED
GRIND SURFACE

USED ON

EXCEPT AS NOTED, FINISH

EXCEPT AS NOTED, TOLERANCES
FRAC. DIM. ± WELD-CSTG DIM. ±
DEG. DIM. ± ANGULAR DIM. ±

ISSUE	ISSUE DATE AND CHANGE RECORD	REV.	CH.
	DIM. WAS .172 (8-13-57)	B	
5.	DIM. WAS .118 (8-13-57)	A	
4.	[illegible] (7-26-57)	A	[illegible]
3.	ADDED [illegible] (7-1-57)	A	[illegible]
2.	ADDED [illegible] (6-30-57)	A	[illegible]
1	6-26-57		

TITLE
PARALLEL - HOT SHOE

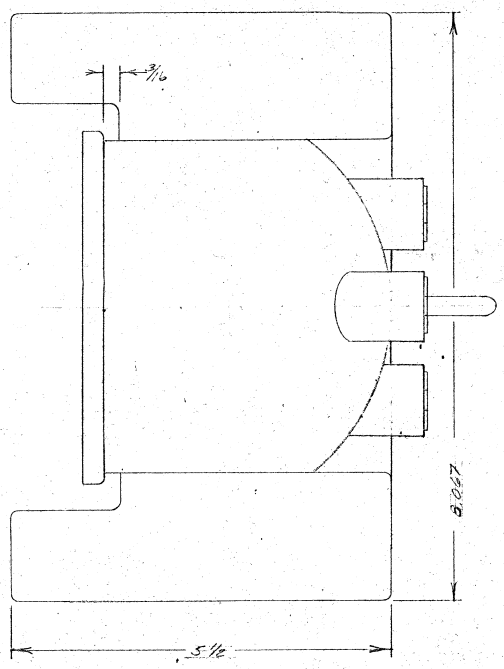
C 7E-3A 7

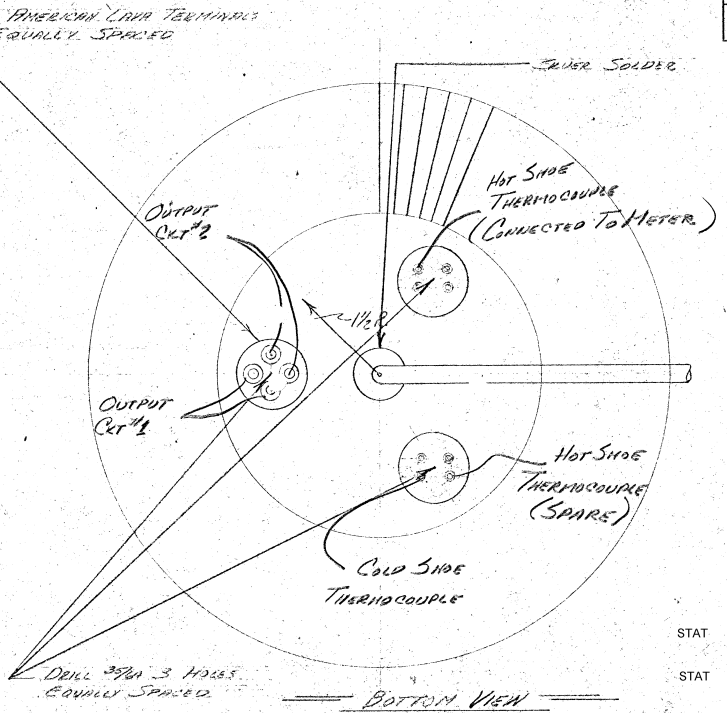
25X1

SILVER SOLDER TERMINALS, TUBULATION & TUBULATION FITTING USING EUTECTIC 1801 OR EQUIVALENT PART AND INSIDE OF TUBULATION TO BE FREE OF FLUX RESIDUES AND OXIDE FILMS.

SOFT SOLDER TERMINAL CONNECTIONS TO LOWER SHELL.

COMPLETED PART TO HAVE A MAX. OF 3.0 DIVISIONS OF DEFLECTION AS DETERMINED ON HELIUM MASS SPECTROMETER DETECTOR.





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NOTE:
80 PINS EQUALLY SPACED
USE HYBRAZ 560°F MELT SOLDER
USE 3 AMERICAN LAVA TERMINALS

NOTE:
USE 1 4 LEAD OUTPUT TERMINAL
DISK DWG # D-TE-3A-29
USE 2 4 LEAD THERMOCOUPLE TERMINAL
DISK DWG # D-TE-3A-28

USED ON				
EXCEPT AS NOTED, FINISH	1	8-25-59		
EXCEPT AS NOTED, TOLERANCES FRAC. DIM. ± WELD-CSTG DIM. ± DEC. DIM. ± ANGULAR DIM. ±	ISSUE	ISSUE DATE AND CHANGE RECORD	REV.	CH.

TITLE: LOWER SHELL SUB ASSEMBLY 3D-2

C | TE-3A | 27

25X1

Enclosure 3

STAT

DESIGN CALCULATION OUTLINE, GENERATOR [redacted]

Temperature Hot Junction - - - - - - - - 1100 F.

Temperature Cold Junction - - - - - - - 200 F.

Material Efficiency - - - - - - - - - - 8.16%

ρ_N (Ave. resistivity of "N" element) - - - - - - - 1220 $\mu\Omega$-in.

ρ_P (Ave. resistivity of "P" element) - - - - - - - 1610 $\mu\Omega$-in.

$V_{p,n}$ (Seebeck EMF of one couple) - - - - - - - - - 243 mv. @ 900 F. T

$\frac{An}{Ap}$ = .851 = Ratio of area of "N" element to area of "P" element.

Number of couples = $\frac{15 \text{ volts} \times 2}{.243 \text{ volts}} \cong 125$ couples

Load Resistance = $\frac{(15)^2}{10} = 22.5\Omega$ Internal Resistance = $\frac{22.5}{1.05} = 21.4\Omega$

Assume 1" length, then Dia of "P" element = .151 in.
Dia of "N" element = .140 in.

Estimated overall efficiency:
Fuel burning efficiency (estimate) - - - - - 60 per cent
(including exhaust losses)
Thermoelectric materials efficiency - - - - 8.16 per cent
Heat insulation efficiency - - - - - - - - - 80 per cent
Net overall efficiency = .60 x .0816 x .80 = 3.92 per cent

Fuel Required:

Heat value of regular leaded gasoline = 21,050 Btu/#

10 Watts = 34.1 Btu/Hour output

$$\frac{34.1}{31{,}050 \times .0392} = .041 \text{ \#/Hour}$$